

**REMARKS**

Claims 1-16 are pending in this application. By this Amendment, claims 1 and 14 are amended, and claims 15 and 16 are added.

Claims 1 and 14 are amended to recite a metal base layer containing vanadium, and an intermediate layer that is formed "directly on the metal base layer." Support for this amendment may be found at least at paragraphs [0026] and [0030] of the specification.

Claim 15 recites the hydrogen permeable membrane of claim 1, wherein the metal base layer is non-porous. Support for this claim may be found at least at paragraph [0026], wherein the metal base layer is described as possessing excellent hydrogen permeability, thus indicating that the metal base layer is non-porous.

Claim 16 recites the features described at paragraph [0025] and shown in Figure 1 of the specification.

No new matter is added.

**Rejection Under 35 U.S.C. §102(b)**

Claims 1, 2 and 13 are rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Ito (U.S. Patent Application Publication No. 2003/0061937).

Claims 1, 2 and 13 are patentable over Ito at least because Ito fails to describe an intermediate layer made of a metal having a higher melting point than the metal base layer and the metal coating layer.

Ito describes a hydrogen permeable membrane having a porous base layer comprising vanadium and an intermediate layer containing nickel or cobalt (paragraph [0044]). Both nickel and cobalt have melting points that are *lower* than vanadium (melting point of Ni = 1453°C; Co = 1495°C; V = 1890°C). Ito therefore does not describe or suggest an

intermediate layer made of a metal having a higher melting point than the metal base layer and the metal coating layer. Claims 1, 2 and 13 are thus not anticipated by Ito.

Applicants request withdrawal of the rejection.

**Rejections Under 35 U.S.C. §103(a)**

**Alvin In View Of Ito**

Claims 1-7 and 13 are rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Alvin (U.S. Patent No. 7,018,446) in view of Ito.

Claims 1-7 and 13 are patentable over Alvin in view of Ito at least because the cited combination of references fails to describe a hydrogen permeable membrane including an intermediate layer that is formed directly on the metal base layer and is made of a metal having a higher melting point than the metal base layer and the metal coating layer, as required by claim 1.

Alvin describes a membrane comprising a porous body (10) (the structure allegedly analogous to the metal base layer of claim 1), and having a barrier layer containing aluminum particles (column 3, lines 8-10) between the porous body and the tantalum/niobium interface layer (allegedly analogous to the intermediate layer of claim 1) (column 7, lines 1-11). Thus, Alvin expressly describes that the interface layer (alleged intermediate layer) is not formed directly on the porous body. Rather, there is a barrier layer in between and separating the two layers. Thus, replacing the porous body of Alvin with the base metal layer of Ito, as alleged by the Patent Office, would have resulted in a structure that comprises a barrier layer between the base metal layer and the interface layer. This is different than the structure recited in claim 1, wherein the intermediate layer is formed directly on the base metal layer.

In addition, Alvin describes that when fired, the aluminum of the barrier layer is oxidized, forming alumina that lowers the hydrogen permeability performance of the membrane (column 7, lines 28-31). The alumina combines with iron or nickel in the

substrate to establish an iron aluminide or nickel aluminide spinel within the barrier layer (column 7, lines 12-30).

Ito is discussed above. The base metal layer of Ito is comprised of vanadium, and thus if substituted for the porous body (10) of Alvin, would not enable formation of the iron aluminide or nickel aluminide spinel required by Alvin. Thus, there would have been no reason or rationale for a person of ordinary skill in the art to have combined Alvin and Ito in the manner alleged by the Patent Office with any reasonable expectation of success. The cited combination would have rendered Alvin inoperative for its intended purpose.

For the reasons above, claim 1 is patentable over Alvin in view of Ito. Because claims 2-7 and 13 depend from and include the limitations of claim 1, they are also patentable for at least the same reasons as discussed above regarding claim 1.

Applicants request withdrawal of the rejection.

#### Ma In View Of Ito

Claims 1, 2, 4-6, 10, 13 and 14 are rejected as allegedly being unpatentable over Ma (U.S. Patent No. 7,255,726) in view of Ito.

Claims 1 and 14 are patentable over Ma in view of Ito at least because the cited combination of references fails to describe a metal base layer containing vanadium and an intermediate layer formed directly on the metal base layer.

Ma describes a gas separation module comprising a porous metal substrate having an intermediate layer overlying the metal substrate. Ma describes that the porous metal substrate may be formed of any suitable compounds (column 6, lines 27-47). Among the examples of such suitable compounds, vanadium is not described. Ma thus does not describe a metal base layer containing vanadium.

Further, the substrate is described as being a "support" for a gas (i.e., hydrogen) selective membrane. Nowhere does Ma describe that the substrate itself is gas-selective.

Rather, the membrane overlying the substrate is solely responsible for the hydrogen selectivity of the module (column 5, lines 28-43).

In contrast, the hydrogen permeable membrane of claims 1 and 14 require a metal base layer containing vanadium. The present specification, at paragraph [0026], describes that the metal base layer comprising vanadium possesses excellent hydrogen permeability. Further, the palladium containing metal coating layer of the hydrogen permeable membrane of claim 1 functions as a catalyst layer to promote a dissociative reaction of hydrogen molecules to change the hydrogen molecules to hydrogen atoms, and to prevent oxidation of the vanadium of the metal base layer. The metal base layer thus allows hydrogen to move through only as a hydrogen atom. The porous metal substrate of Ma, on the other hand, allows hydrogen to move as a hydrogen molecule.

Ma thus describes a membrane wherein the metal substrate acts as a support for the hydrogen permeable membrane thereon, and is not itself hydrogen permeable. There is thus no reason or rationale for a person of ordinary skill in the art to have modified the membrane of Ma to have arrived at the hydrogen permeable membrane recited by claims 1 and 14. If, as the Patent Office has suggested, one were to have substituted vanadium as the metal in the porous substrate of Ma, the porous substrate would still have allowed hydrogen to move within the porous substrate as a hydrogen molecule, unlike the metal base layer recited in claims 1 and 14.

In addition, the barrier layer of Ma (allegedly analogous to the intermediate layer of claims 1 and 14) is preferably an oxide (see column 7, lines 60-67 and the Examples). If a vanadium substrate is used wherein the oxide is formed directly on the substrate, the vanadium would be oxidized (as vanadium is easily oxidizable), thus rendering the substrate hydrogen impermeable. The barrier layer of Ma could not prevent oxidation of the vanadium substrate, like the palladium containing layer of claim 1. Replacing the porous metal base

layer of Ma with a vanadium metal base layer would thus have rendered the membrane of Ma hydrogen impermeable.

There would thus have been no reason or rationale for a person of ordinary skill in the art to have combined and/or modified the membranes described by Ma and Ito to have arrived at the hydrogen permeable membrane, and method for making the same, recited in claims 1 and 14, with any reasonable expectation of success.

For the reasons above, claims 1 and 14 are patentable over Ma in view of Ito. Because claims 2, 4-6, 10 and 13 depend from and include the limitations of claim 1, they are also patentable for at least the same reasons as discussed above regarding claim 1.

Applicants request withdrawal of the rejection.

Ito

Claims 4 and 9 are rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Ito.

Ito is cited as above regarding claim 1, and the Patent Office further alleges that the additional features of claims 4 and 9 would have been obvious to one of ordinary skill in the art.

As discussed above, Ito does not describe each of the features of claim 1. Because claims 4 and 9 depend from and include the features of claim 1, they are patentable over Ito for at least the same reasons as discussed above regarding claim 1.

Applicants request withdrawal of the rejection.

Shimanuki In View Of Ito

Claim 12 is rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Shimanuki (U.S. Patent No. 6,740,432) in view of Ito.

Claim 12 is directed to a fuel cell comprising the hydrogen permeable membrane recited in claim 1.

Claim 12 is patentable at least because the cited combination fails to describe the hydrogen permeable membrane recited in claim 12.

Shimanuki is cited by the Patent Office as allegedly describing a fuel cell, but the Patent Office admits that Shimanuki does not describe the hydrogen permeable membrane of claim 1. Ito is thus cited by the Patent Office as above regarding claim 1. The Patent Office alleges that it would have been obvious to have combined the membrane described by Ito with the fuel cell described by Shimanuki to have arrived at the fuel cell of claim 12.

As discussed above, Ito does not describe a hydrogen permeable membrane having the features of claim 1. Thus, the combination of Shimanuki and Ito fails to describe the features of claim 12. Claim 12 is therefore patentable over Shimanuki in view of Ito.

Applicants request withdrawal of the rejection.

#### **Claims 15 And 16**

Claim 15 recites the hydrogen permeable membrane of claim 1, wherein the base metal layer is non-porous. As discussed above, the metal substrate layers described by Alvin and Ma are porous. Alvin and Ma thus fail to describe this additional feature. Claim 15 is therefore patentable for the reasons above regarding claim 1, and also because Alvin and Ma do not describe the additional features recited in claim 15.

Claim 16 recites a hydrogen permeable membrane comprising a metal base layer containing vanadium and having a first face and a second face, wherein the metal base layer is sandwiched between a first face intermediate layer that is formed directly on the first face and a second face intermediate layer that is formed directly on the second face, and wherein is made of a metal having a higher melting point than the metal base layer and the first face metal coating layer containing palladium, and is made of a metal having a higher melting point than the metal base layer and the second face metal coating layer containing palladium, wherein the metal coating layers containing palladium are formed on the intermediate layers.

Given the structure required by claim 16, hydrogen may only move as a hydrogen atom in the metal base layer. The intermediate layers (both the first face intermediate layer and the second face intermediate layer), being hydrogen permeable, allow hydrogen as hydrogen atoms to permeate therethrough, but not hydrogen molecules. Thus, when hydrogen moves between the metal base layer and the intermediate layers and between the intermediate layers and the metal coating layers (both the first face metal coating layer and the second face metal coating layer), the dissociative reaction or the combination reaction of hydrogen molecules is not required (paragraph [0032] of the specification). Thus, diffusion of metal between the metal base layer and the metal coating layers is prevented.

The metal base layers of both Alvin and Ma, on the other hand, are porous, and are not sandwiched between two intermediate layers and two metal coating layers, as required by claim 16. Therefore, hydrogen may move as a hydrogen molecule in the metal base layers of Alvin and Ma, thus allowing the hydrogen permeability of the membrane to deteriorate due to diffusion of metal between the metal base layer and the metal coating layer.

Claim 16 is thus patentable over Alvin and Ma for the above reasons. In addition, Claim 16 is also patentable over Ito, Alvin, Ma and Shimanuki, and combinations thereof, for the reasons discussed above regarding claim 1, because claim 16 contains limitations analogous to claim 1, along with the additional limitations recited therein.

#### **Allowable Subject Matter**

Applicants appreciate the indication that the subject matter of claims 8 and 11 is allowable. Applicants submit that claims 8 and 11 are also patentable for the reasons discussed above regarding claim 1.

**Conclusion**

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-16 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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Date: July 22, 2009

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